GEOTECHNICAL REPORT

HOME SUBDIVISION – PHASE B

FOR

GREEN CROW INVESTMENTS CO. LLC

ROLLING HILLS WAY & COMFORT WAY, SEQUIM, WA

8/5/19

PREPARED BY:

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PROJECT NO. 18252

GEOTECHNICAL REPORT

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FOR

GREEN CROW INVESTMENTS CO. LLC

ROLLING HILLS WAY & COMFORT WAY, SEQUIM, WA

1.0 INTRODUCTION

Zenovic & Associates, Inc. was retained by Green Crow Investments Company LLC to conduct a geotechnical investigation of the site for Phase B of the Home Subdivision located at the end of Rolling Hills Way and Comfort Way off of Silberhorn Road in Sequim, Washington. Phase B of the Home Subdivision includes 33 lots intended for single family residential use.

1.1 Site Location

The site is located on parcel number 03-30-30-59-0000 at the south end of the existing Rolling Hills Way and Comfort Way in Sequim, Washington. The subject property is within the SW ¼ of Section 30, Township 30 North, Range 3 West, W.M. The site is at latitude 48° 03' 55" North and longitude 123° 07' 22" West. The site location is shown on the Site Vicinity Map, Appendix A.

1.2 Proposed Construction

We understand that the proposed project consists of installation of infrastructure as needed to support 33 single family residences including roadways, sidewalks, and water, power, sewer and stormwater facilities. Roadway usage will be primarily for light automobiles with the occasional delivery and refuse/recycling trucks. Significant usage by large commercial vehicles is not expected.

1.3 Purpose

The purpose of this investigation was to evaluate the soil and groundwater conditions at the site, and to make geotechnical engineering recommendations for use in the development of the site and associated building construction schemes as well as for infrastructure design, including vehicle and pedestrian access, and the management of storm water runoff.

2.0 SITE INVESTIGATION

2.1 Site Description

The site lies south Comfort Way and Rolling Hills Way in Sequim, WA. Phase A of the Home Subdivision was constructed just to the north of the project site. Construction of Phase A included extending the roadways for Comfort Way and Rolling Hills Way to the edge of Phase B as well as extending sewer and water to the edge of the property.

An existing 8" diameter water main was previously installed through the project site to provide connectivity in the Silberhorn Road area. This line is intended to remain and will be located within the extended Comfort Way right of way. An additional 12" diameter water main crosses the southern portion of the site and is a transmission line from the Dungeness Infiltration Gallery.

A stormwater catchment system consisting of type 2 catch basins and 24" diameter storm piping was installed along the southeast property line. It appears that this system was installed to capture surficial offsite runoff and convey it around the subject property.

The site has been previously cleared although several large oak trees remain in the central portion of the site. The remainder of the site is vegetated with field grass and low brush (blackberries, wild rose, snowberry, etc.)

The site is generally level with a slight grade (3%) to the north. The adjacent property to the southeast contains a steep slope which parallels the southeastern property line of the site. This slope varies in height from approximately 30' to 50' and has an average slope of 50%. The area above this slope is pasture land and slopes to the northwest at grades between 5-8%.

The slope southeast of the site is well vegetated with a mix of deciduous and evergreen trees and low shrubs.

There were no defined drainage channels observed on the site.

2.2 Geologic Setting

The site lies within the Strait of Juan de Fuca branch of the Georgia Depression. The Strait of Juan de Fuca Branch was occupied by the Juan de Fuca lobe of the Cordilleran ice sheet during the Vashon Stade of the Fraser Glaciation.

The Washington Division of Geology and Earth Resource (WDGER), Geologic Map of Washington – Northwest Quadrant, dated 2002, indicates that the site is located in an area mapped as Qoa - non-glacial Older Alluvium, undivided (Holocene). Older Alluvium consists of stratified gravel, cobbles, sand and silt in terraces above modern flood plains. It is not uncommon for soils to be iron stained. These areas include alluvial-fan, landslide, and colluvial deposits. No active or inactive fault lines are found in the project vicinity. See Appendix D for geologic setting map.

The adjacent slope and area above the slope are mapped as Qgd - Vashon Drift, undivided (Pleistocene). Vashon drift consists of random mixtures of sand and gravel, lodgment till, sandy ablation till, and lacustrine silts.

2.3 USDA Soil Conservation Service Soils Information

The USDA National Resources Conservations Services (NRCS) soil report for the site indicates that the near surface soils at the site consists of Sequim very gravelly sandy loam and Sequim-McKenna-Mukilteo complex. Soils on and above the steep slope on the adjacent property consist of Clallam gravelly sandy loam. See appendix E for NRCS soil report.

Sequim very gravelly sandy loam is an outwash material typically consisting of gravelly sandy loam near the surface (0-10 inches deep), extremely cobbly loamy sand from 10-23 inches and extremely cobbly sand below with a depth to water table or restrictive layer of greater than 80 inches. The soils are classified as a group A hydrologic soils (soils having a high infiltration rate (low runoff potential) when thoroughly wet. These soils consist mainly of deep, well drained to excessively drained sands or gravelly sands, and have a high rate of water transmission).

The Sequim-Mckenna-Mukilteo soils consist of a mixture of soil types. The Sequim soil portion is as described above. The Mckenna and Mukilteo portions are more poorly drained finer materials with limited depths to groundwater or restrictive layer.

The Clallam gravelly sandy loam soils have moderate permeability to a glacial till layer and very slow through it. Available water capacity is low, runoff is medium, and the hazard of water erosion is slight.

2.4 Subsurface Exploration

Ten (10) test pits were excavated at random, representative locations throughout the site. Test pit locations and logs are included in Appendix B. Test pits were advanced to depths ranging from 6 feet to 10 feet. Typically, the soil conditions consisted of minimal sandy loam topsoil over extremely cobbly loamy sand. Soils in the southwestern portion of the site tended to included additional loam and muck materials in the near surface soils consistent with the McKenna and Mukilteo soil types. 5 soil samples were collected as indicated on the test pit logs. A sieve analysis of each of the materials was completed and results are included in Appendix B.

2.5 Groundwater

Test pits 5-7 exhibited some signs of some signs of groundwater or perched water with scattered inclusions of mottled loam and or loam/clay bands. Test pit #6 specifically was moist at the bottom of the pit, but no standing water was observed.

No groundwater or perched water was encountered and no significant evidence (mottling or gleying) of the soil, indicating perched water or saturated soils, was observed in any of the other test pits.

2.6 Seismic Information

Site specific data is not available to a depth of 100 feet. Available geologic data, however, indicates that a Site Design Class D as per Table 1613.5(2) of the International Building Code is appropriate for this site.

Ground motion accelerations for the site were obtained from the Structural Engineers Association of California (SEAOC) Seismic Design Mapping website. The latitude/longitude method was used to obtain ground motions at latitude of 48.06547 degrees N and longitude of 123.12273 degrees W. The results of the analysis are included in Appendix D.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 General

The recommendations for design and construction presented in the following sections are based on our understanding of the proposed construction (Section 1.2), engineering assessment of the anticipated subsurface conditions (Section 2.4), and experience with similar projects in similar soil conditions. If there is any change in the project criteria, a review should be made by this office prior to final design and construction at the site.

3.2 Building Foundations

Based on our understanding of the proposed uses at the project, typically structures will consist of single-family residences constructed on conventional concrete foundations or concrete slab on grade. Excavations for footings and slabs on grade should be carried to firm and unyielding native bearing materials. In this case this material is typically the extremely cobbly sand below the surficial sandy loam materials.

We recommend that a vertical allowable bearing capacity of 2,000 pounds per square foot (psf) should be used for the design of the foundation where the extremely cobbly sand is reached. A lateral allowable bearing capacity of 150 psf per foot of depth and a sliding coefficient of 0.25 are recommended. See table 1806.2 of the International Building Code (2018) for further information.

3.3 Slab on Grade Construction

We recommend that the slabs-on-grade be separated from the exterior foundation system (independent footing/stemwall and slab construction) rather than a monolithic pour construction to accommodate anticipated differential settling that may occur due to the potential variability of the subsurface soils. Any unsuitable or unconsolidated material under the slab should be removed and replaced with suitable structural fill or scarified and recompacted. Fill or replaced material should be compacted to 92% of maximum dry density as determined by ASTM-D-1557.

A 6" thick of gravel backfill capillary break material conforming to the requirements of WSDOT Standard Specification Section 9-03.12(4) should be placed on the prepared slab subgrade and consolidated with a vibratory plate compactor until this layer is dense and unyielding. Approximately 1" to 2" below the slab bottom grade, a layer of minimum 6 mil thickness polyethylene vapor barrier should be installed; layer seams should lap no less than 12 inches. A layer of well drained sand conforming to Section 9-03.13 of the Standard Specifications should be placed up to the slab bottom grade to enhance the absorption of concrete bleed water and improve concrete cure and finishing.

3.4 Roadways

Excavation for roadways should be extended to firm and unyielding native bearing materials. In this case this material is typically the extremely cobbly sand below the surficial sandy loam materials. Unsuitable or unconsolidated materials encountered should be excavated and replaced with structural fill and compacted to 95% dry density as determined by ASTM-D-1557 or, if materials are suitable for use, scarified to a minimum depth of 12" and compacted to 95% dry density.

The following structural section is recommended for this site and anticipated traffic loads and volumes:

Roadways	Sub-base	8" min. of ballast per WSDOT 9-03.9(1)
	Top rock	3" min. of CSTC per WSDOT 9-03.9(3)
	Pavement	3" min. of HMA Class ½" PG64-22

3.5 Drainage

Soils onsite are relatively free-draining and based on observed conditions have significant depth to groundwater or other restrictive layer. Soil samples collected from the site were analyzed for grain-size distribution which was then correlated to design infiltration rates pre recommendations in the *Stormwater Management Manual for Western Washington (ECY, 2014).* Based on those correlations and observed site conditions a design infiltration rate of 5 inches per hour is conservative.

Runoff from the roadways should be primarily in the more free-draining materials located in the northeastern portion of the site. Runoff from residences and associated driveways, pathways, etc. should be infiltrated on each individual parcel through the use of infiltration trenches or rain garden/bioretention areas. Infiltration trenches should be sized to include 20 lineal feet of infiltration trench per every 1,000 square feet draining to them. Further guidelines for layout and installation of stormwater infiltration facilities can be found in the *Stormwater Management Manual for Western Washington (ECY, 2014).*

3.6 Groundwater Influence on Structures/Construction

No impact on the proposed construction from groundwater is anticipated.

3.7 Offsite Steep Slope

Based on review of site conditions and available historical record, the existing slope located southeast of the site has minimal risk of slope failure. Any failure is likely to be in the form of slow soil creep and no large-scale failures are anticipated. A setback of 20' from the property line adjacent to this slope is recommended. This setback will effectively maintain a setback of 30' from the toe of the slope. Reductions in this setback may be allowed, but must be supported by further site specific recommendations by a geotechnical engineer or geologist.

4.0 CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

4.1 General

Variations in soil conditions are anticipated to be encountered during construction. In order to correlate design concepts with actual soil conditions, we recommend that technical or engineering personnel be present to provide monitoring and geotechnical engineering services during construction and to assist in developing design changes in the event that subsurface conditions differ from those outlined in his report.

The following sections of this report include comments on items related to excavation, dewatering, foundation construction, earthwork, and related geotechnical aspects of the proposed construction. This section is written primarily for the engineer responsible for the preparation of plans and specifications for the work. This section also addresses construction issues related to foundations and earthwork and will aid personnel who monitor construction activities.

The contractor must evaluate potential construction problems on the basis of their knowledge and experience in this area and on the basis of similar projects in other localities, taking into account their own proposed construction methods and procedures.

4.2 Construction Excavation Slopes

The Contractor should become familiar with and be aware of applicable local, state, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Construction site safety is the sole responsibility of the Contractor, who shall also be solely responsible for means, methods, and sequencing of construction operations. Zenovic & Associates, Inc. is providing this information solely as a service to our Client. Under no circumstances should the information provided below be interpreted to mean that Zenovic & Associates, Inc. is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

The Contractor should be aware that slope height, slope inclination, or excavation depths should in no case exceed those specified in local, state, or federal regulations, e.g. OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if they are not followed, the Contractor or its subcontractors could be held liable for substantial penalties.

For this site, subsurface conditions encountered include sandy soils. Generally sandy soils are considered Type C soils when applying OSHA regulations. For excavations less than 20 feet deep OSHA recommends a maximum slope of 1.5 horizontal to 1 vertical for Type C soils.

The soils penetrated by the proposed excavations may vary significantly across the site. Our preliminary soil classification is based on discrete test pit excavations. The Contractor should continually classify the soils that are encountered as excavation progresses with respect to the OSHA system.

For excavations that are extended to a depth of more than 20 feet it will be necessary to have side slopes designed by a professional engineer registered in the State of Washington. It is likely that slopes flatter than those outlined above will be required. This side slope design, if such conditions are anticipated, should be a required construction submittal.

As a safety measure, it is recommended that all vehicles and soils piles be kept a minimum lateral distance of 2 feet from the crest of the slope as recommended by OSHA. The exposed slope face should be protected against the elements.

4.3 Site Grading and Earthwork

A. Site Preparation

All areas that will support footings, floor slabs, exterior concrete and pavements should be properly prepared. All wood debris at the near surface should be removed and not incorporated into any fill materials. After rough grade has been established in cut areas and prior to any placement of fill in fill areas, the exposed subgrade should be carefully inspected by probing and testing as needed. Any topsoil or other organic materials still in place, frozen, wet, soft, or loose soil and other undesirable materials, as determined by the geotechnical engineer, should be removed.

The exposed subgrade should further be evaluated by proof rolling with a heavy weight vehicle to check for pockets of soft material hidden beneath a thin crust of dense soil. Any unsuitable materials thus exposed should be removed. The exposed materials should be scarified, and moistened or dried if necessary, to a minimum depth of 12 inches. The scarified material should then be compacted as outlined in Section 4.3(E) of this report. Areas where stable soils are encountered at subgrade levels should also be scarified and compacted as outlined in Section 4.3(E) prior to fill placement.

Care should be exercised during the grading operations on the site. The grading should be done during the dry season, if at all possible. While the near surface soils do not appear to have significant silts and clays that could cause pumping and general deterioration of the surface soils, excessive traffic of heavy equipment (including heavy compaction equipment) should be avoided if excess surface water is present.

B. Fill Placement and Compaction

Fill should be placed in maximum 8-inch loose lifts and compacted according to the specifications outlined in Section 4.3(E). Only lightweight compaction equipment (hand-held or walk behind) should be operated adjacent to foundation and retaining walls.

Field density tests should be performed on each lift as necessary to verify that adequate compaction is being achieved. Compaction of any material by flooding is not considered acceptable. This method will generally not achieve the desired compaction and the large quantities of water will tend to soften and/or cause swelling of the deep subgrade soils.

C. Structural Fill

Structural fill should be non-plastic material with less than 10% fines (percent passing the No. 200 sieve). Material meeting the requirements for gravel Base per Section 9.03.10 of the WSDOT Standard Specifications On-site soils are likely suitable for structural fill but must be approved on an a case-by-case basis.

Any fine soils, consisting of silt or clay material, are not considered suitable for structural fill. Any imported structural fill should be tested and approved prior to use on the site.

D. Utility Trench Backfill

Utility trench backfill placed in or adjacent to streets, buildings or exterior slabs should be compacted as recommended in Section 4.3(E) of this report. Pipe bedding should be in accordance with pipe manufacturer's recommendations and approved project plans.

E. Recommended Compaction Specifications

Recommended compaction specifications are as follows:

1. Structural fill and recompacted native soils beneath footings

   Granular soils should be compacted to 95% of the maximum dry density as determined by Modified Proctor (ASTM D-1557) within +/- 2% of optimum moisture content; cohesive soils are not recommended for this application

2. Structural fill and recompacted native soils beneath floors slabs and behind foundation walls

   Granular soils should be compacted to 92% of the maximum dry density as determined by Modified Proctor (ASTM D-1557) within +/- 2% of optimum moisture content; cohesive soils are not recommended for this application

3. Structural fill and recompacted native soils beneath pavements, exterior concrete, and general site fill

   Granular soils should be compacted to 95% of the maximum dry density as determined by Modified Proctor (ASTM D-1557) within +/- 2% of optimum moisture content; cohesive soils should be compacted to 95% of maximum dry density as determined by Modified Proctor with moisture within -1% to +3% of optimal

4. Utility trench backfill in and adjacent to roads, building and exterior slabs

   Granular soils should be compacted to 95% of the maximum dry density as determined by Modified Proctor (ASTM D-1557) within +/- 2% of optimum moisture content; cohesive soils should be compacted to 95% of maximum dry density as determined by Modified Proctor with moisture within -1% to +3% of optimal

F. Infiltration System Excavation

Care should be taken when constructing infiltration facilities to prevent "blinding" (decrease in infiltrative capacity by filling of voids with fine materials) and over compaction of receptor materials. Infiltration facilities should be protected from receiving sediment laden runoff through the use of berms, silt fence or other means to direct water away from the facilities during construction. Heavy equipment shall not traverse the bottom of infiltration facilities and bottom and sides of facilities should be scarified prior to backfill.

4.5 Groundwater Considerations

Groundwater conditions are described in Section 2 of this report. At the time of our investigation, groundwater was not encountered within anticipated excavations depths at the site. The need for construction dewatering at this site is not anticipated.

Based on our findings, it does not seem feasible that groundwater may rise within the zone of structural influence or affect the construction of foundations and pavements for the project. However, if earthwork is performed during or soon after periods of precipitation, the subgrade soils may become saturated, pump, or not respond to densification techniques. Typical remedial measures include discing and aerating the soil during dry weather, mixing the soil with dryer material, removing and replacing the soil with an approved fill material, or mixing the soil with an approved lime or cement product. Our firm should be consulted prior to implementing remedial measures to observe unstable subgrade conditions and provide appropriate recommendations.

5.0 REVIEW AND CONSTRUCTION OBSERVATIONS

Variations in subsurface conditions will likely be encountered during construction at the site. To permit correlation between the investigation data and the conditions encountered during construction, and to provide conformance with the plans and specifications as originally contemplated, it is recommended that a geotechnical engineer be retained to provide continuous observations of construction operations and to provide quality control testing of fill, asphalt, and base course placement and compaction.

6.0 LIMITATIONS

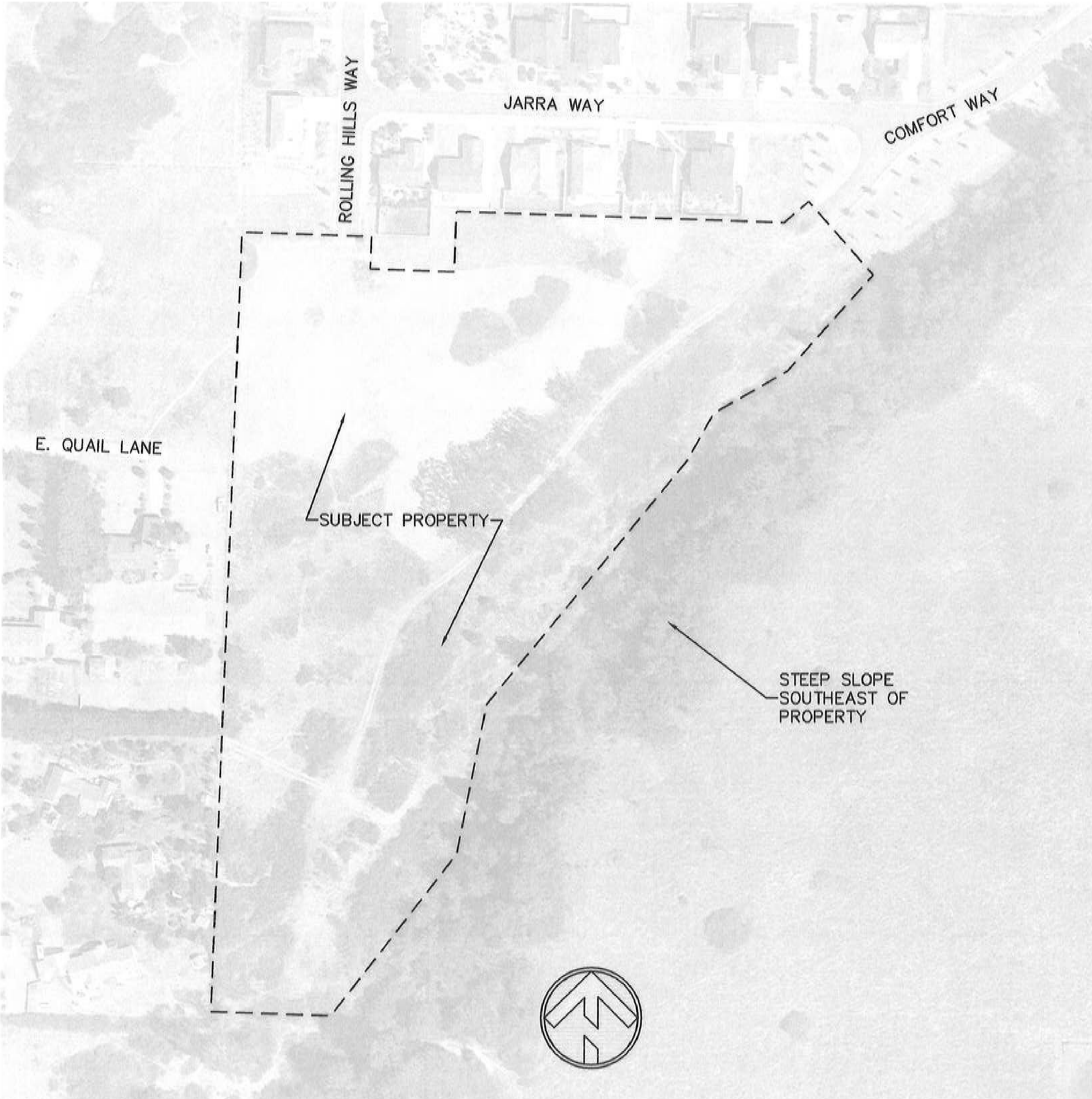
This report has been prepared for Green Crow Investments Company LLC and their selected design consultants for use in the development of the subject project. Information provided in this report has been collected and interpreted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions, and in accordance with sound and generally accepted principles consistent with normal consulting practice. No other warranty, expressed or implied, including (but not limited to) any warranty or merchantability or fitness for a particular use has been made.

In the event that change in nature, design, or location of the proposed construction is made, or any physical changes to the site occur, recommendations are not considered valid unless the changes are reviewed by our firm and conclusions of this report are modified or verified in writing.

The scope of Zenovic's services did not include an environmental assessment for the presence or absence of 1) hazardous and/or toxic materials, in the soil, groundwater, surface water, or atmosphere, and 2) wetlands. Any statements or absence of statements in this report on any subsurface exploration log regarding staining or odor of soil, groundwater, surface water, unusual or suspicious items, or conditions observed are strictly descriptive information for Green Crow Investments Company LLC.

Appendix A

Location Map



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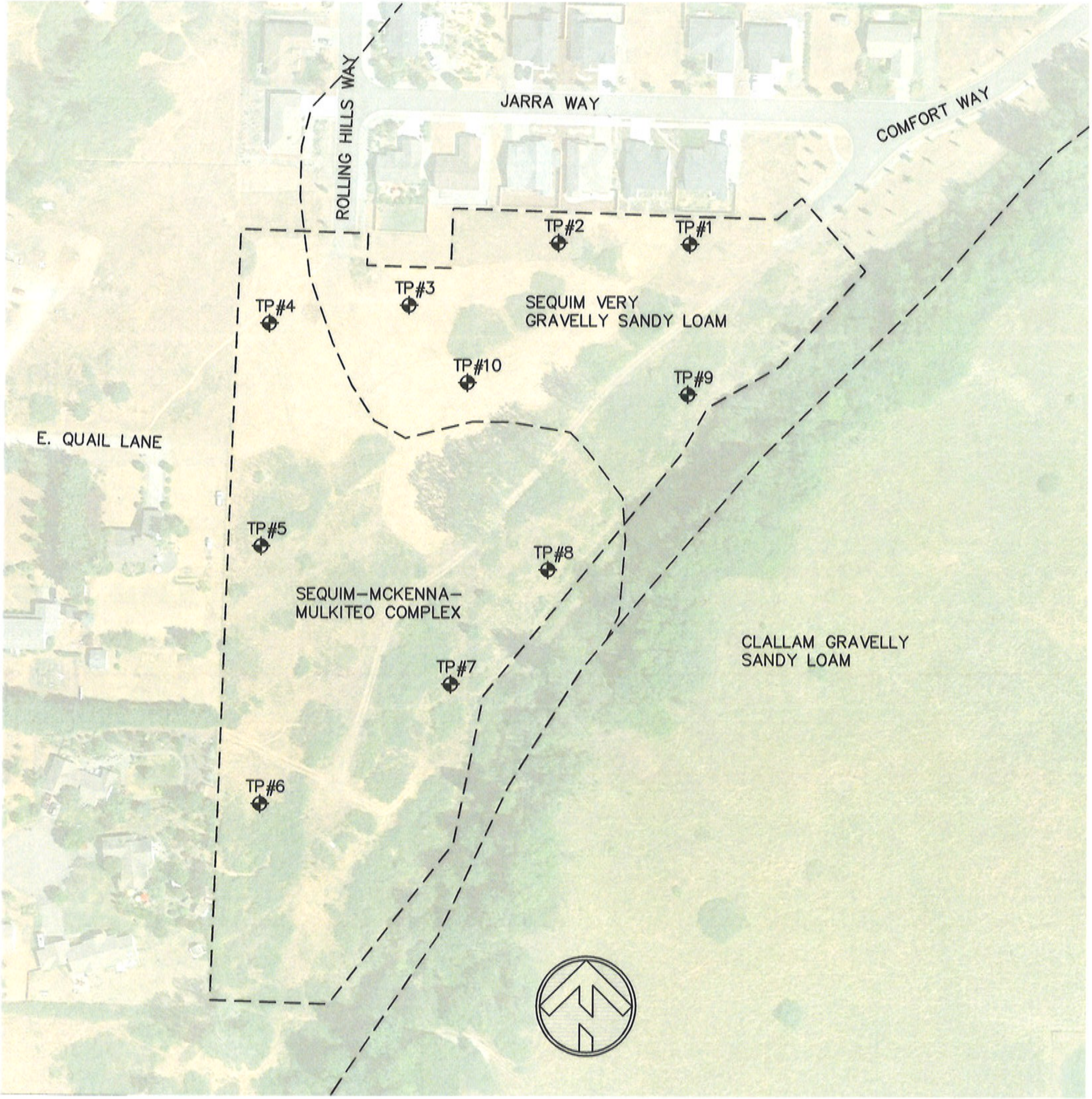
DATE: 8/5/2019	EXHIBIT 1 - LOCATION MAP	1
JOB NO: 18252	CLIENT: GREEN CROW INVESTMENTS CO. LLC P.O. BOX 2439 PORT ANGELES, WA 98362	
FILE: EP–G	ZENOVIC & ASSOCIATES INCORPORATED 301 EAST 6TH ST. SUITE 1 PORT ANGELES, WA 98362 PHONE: (360) 417–0501 FAX: (360) 417–0514 EMAIL: ZENOVIC@ZENOVIC.NET	OF 1

Appendix B

Test Pit Logs and Mapping



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DATE: 8/5/2019			
JOB NO: 18252	CLIENT: GREEN CROW INVESTMENTS CO. LLC P.O. BOX 2439 PORT ANGELES, WA 98362	ZENOVIC & ASSOCIATES INCORPORATED 301 EAST 6TH ST. SUITE 1 PORT ANGELES, WA 98362 PHONE: (360) 417-0501 FAX: (360) 417-0514 EMAIL: ZENOVIC@ZENOVIC.NET	OF 1
FILE: EP-G			

TEST PIT TP- 1

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 323.0
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-0.33' sandy Loam (Topsoil)				
	GP/ GW	0.33'-7.0' sandy Gravel w/cobbles				
5						
10						
15						

Excavation Contractor: Owner Excavation Equipment: Track hoe Operator: Bruce Emery	Excavation Date: 8/2/18 Z&A Representative: SJR Page 1 of 1

TEST PIT TP- 2

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 324.0
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-1.0' sandy Loam (Topsoil)				
	GP/ GW	1.0'-4.0' sandy Gravel w/cobbles				
5	SW/ SP	4.0'-6.66' very gravelly Sand w/cobbles (Pockets of clean sand)				
			S-1	**Grab**	**6.5**	GP/GW
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR
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TEST PIT TP- 3

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 326.5
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-1.0 sandy Loam (Topsoil)				
	GP/ GW	1.0'-3.0' loamy sandy Gravel w/cobbles				
5	GP/ GW	3.0'-7.0' sandy Gravel w/cobbles				
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR

TEST PIT TP- 4

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 326.5
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-1.0 sandy Loam (Topsoil)				
	GP/ GW	1.0'-3.33' loamy sandy Gravel w/cobbles				
5	GP/ GW	3.33'-6.67' sandy Gravel w/cobbles (very large cobble 18"diameter and larger)				
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR
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TEST PIT TP- 5

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 335.5
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-2.0' Brownish-Black Gravelly Topsoil				
	SM/ ML	2.0'-4.0' very gravelly Silt				
5	GW/ GP	4.0'-7.0'sandy Gravel w/cobbles (with bands/pockets of gray silt)	**S-1**	**Grab**	**6.5**	GP/GW
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR
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TEST PIT TP- 6

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 344.0
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-1.0' Brownish-Black Gravelly Topsoil				
	SM/ ML	1.0'-2.5' Very Gravelly Sandy Loam w/cobbles				
	GW/ GP	2.5'-5.33'Sandy Gravel w/cobbles (moist band of mottled loam/clay at 60")				
5		Unable to progress excavation further due to large cobbles				
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR
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TEST PIT TP- 7

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 340.5
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-1.0' sandy Loam (topsoil)				
	GM/ GP	1.0'-2.67' loamy sandy Gravel w/cobbles				
	GW/ GP	2.67'-6.67' sandy Gravel w/cobbles (scattered inclusions of mottled loam)				
5						
			S-7	Grab	6.0	SW/SP
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR
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TEST PIT TP- 8

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 337.0
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-0.83' sandy Loam (topsoil)				
	SM/ ML	0.83'-2.67' gravelly sandy Loam				
	GW/ GP	2.67'-5.5 sandy Gravel w/cobbles (dense at bottom)				
5						
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR
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TEST PIT TP- 9

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 329.5
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-1.0' sandy Loam (topsoil)				
	GM/ GP	1.0'-2.0' loamy sandy Gravel				
	GW/ GP	2.0'-5.0 sandy Gravel w/cobbles	**S-9**	**Grab**	**5**	GW/GP
5						
10						
15						

Excavation Contractor: Owner
Excavation Equipment: Track hoe
Operator: Bruce Emery

Excavation Date: 8/2/18
Z&A Representative: SJR

TEST PIT TP- 10

Project Name: Home Subdivision – Phase B
Client: Green Crow Investments Co. LLC
Project Number: 18252

Test Pit Elevation: 330.0
Test Pit Location: See Site Plan.
Depth to Groundwater: None encountered

DEPTH (FT.)	USGS Classification	VISUAL PHYSICAL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SAMPLE DEPTH (FT.)	LABORATORY TESTING RESULTS FOR SAMPLE
0	OL	0'-1.0' sandy Loam (topsoil)				
	GM/GP	1.0'-2.5' loamy sandy Gravel				
	GW/GP	2.5'-6.0 sandy Gravel w/cobbles				
5						
10						
15						

Excavation Contractor: Owner Excavation Equipment: Track hoe Operator: Bruce Emery	Excavation Date: 8/2/18 Z&A Representative: SJR Page 1 of 1

Appendix C

Sieve Analyses and Infiltration Rate Calculations

NTI MATERIALS TESTING LABORATORY

Engineers - Land Surveyors - Geologists
Construction Inspection - Materials Testing

NTI 717 SOUTH PEABODY, PORT ANGELES, WASHINGTON 98362, (360) 452-8491

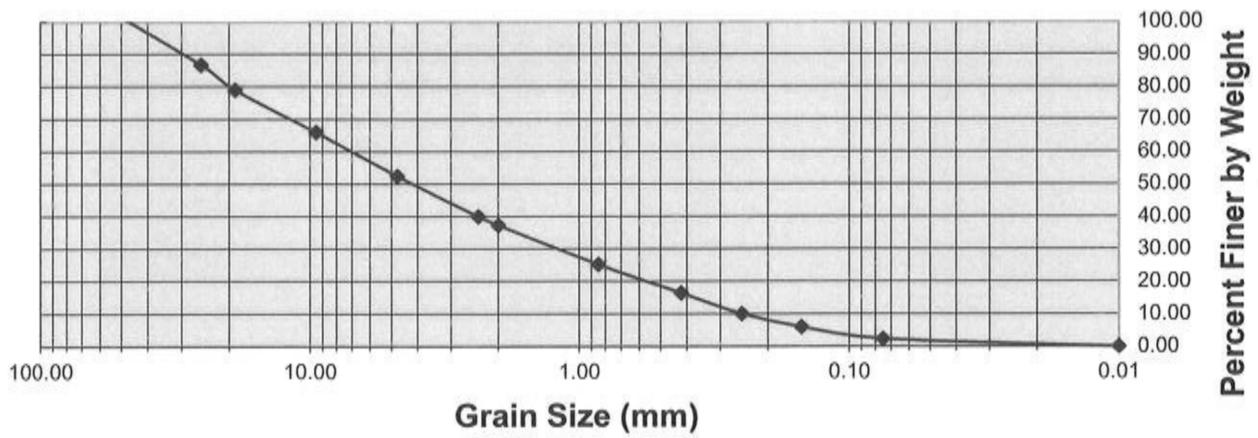
Specimen Control #	18198

GRADATION SIEVE ANALYSIS
ASTM C-136

Client:	Zenovic & Associates	Date:	Collected on 8/2/2018
Project:	Ref# 18252	Sample taken by:	Seth Rodman
BILLING INFORMATION		Material:	**#2**
Lab Account #:	ZZCLAB-22	Source:	
Client Contact:	Seth Rodman	Tested By:	S. West
Email:	zenovic@olympus.net	Date Tested:	9/19/2018
Phone#:	360-471-0501	Test requested:	Wet / Dry Sieve: WET
Remarks:		Reviewed:	D. Eaton

Sieve Dia (mm)	Sieve Size	Dry Wt. (grams)	% Retained	% Passing
50.800	**2"**	0.0	0.0%	101.8%
25.400	**1"**	1357.4	15.0%	86.8%
19.000	**3/4"**	699.9	7.7%	79.1%
9.510	**3/8"**	1192.4	13.1%	66.0%
4.750	**#4**	1222.8	13.5%	52.5%
2.380	**#8**	1132.8	12.5%	40.0%
2.000	**#10**	243.6	2.7%	37.3%
0.850	**#20**	1095.8	12.1%	25.2%
0.420	**#40**	797.7	8.8%	16.5%
0.250	**#60**	575.9	6.3%	10.1%
0.150	**#100**	370.8	4.1%	6.0%
.075	**#200**	335.7	3.7%	2.3%
0	**Pan**	210.7	2.3%	

Start Weight:	9235.5
End Weight:	9076.1
Washed Weight	159.4
D10:	0.14
D30:	1.30
D60:	7.00
Cu:	50.00
Cc:	1.72
Soil Classification:	GW or GP



REMARKS:

NTI MATERIALS TESTING LABORATORY
Engineers – Land Surveyors – Geologists
Construction Inspection – Materials Testing
NTI
717 SOUTH PEABODY, PORT ANGELES, WASHINGTON 98362, (360) 452-8491

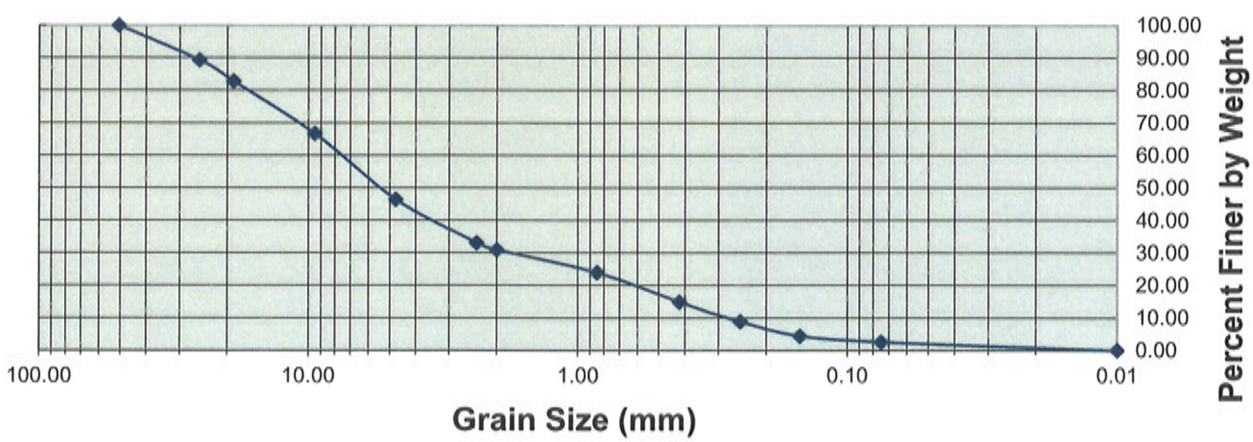
Specimen Control #	18199

GRADATION SIEVE ANALYSIS
ASTM C-136

Client:	Zenovic & Associates	Date:	Collected on 8/2/2018
Project:	Ref#18252	Sample taken by:	Seth Rodman
BILLING INFORMATION		Material:	**#5**
Lab Account #:	ZZCLAB-22	Source:	#5 test pit
Client Contact:	Seth Rodman	Tested By:	Zack Olson
Email:	zenovic@olympus.net	Date Tested:	9/20/2018
Phone#:	360-471-0501	Test requested:	Wet / Dry Sieve: WET
Remarks:		Reviewed:	S. West

Sieve Dia (mm)	Sieve Size	Dry Wt. (grams)	% Retained	% Passing
50.800	**2"**	0.0	0.0%	100.0%
25.400	**1"**	1248.7	10.6%	89.4%
19.000	**3/4"**	771.4	6.6%	82.8%
9.510	**3/8"**	1891.4	16.1%	66.7%
4.750	**#4**	2377.5	20.2%	46.5%
2.380	**#8**	1564.2	13.3%	33.1%
2.000	**#10**	260.8	2.2%	30.9%
0.850	**#20**	808.3	6.9%	24.0%
0.420	**#40**	1073.5	9.1%	14.9%
0.250	**#60**	712.0	6.1%	8.8%
0.150	**#100**	517.4	4.4%	4.4%
.075	**#200**	222.0	1.9%	2.5%
0	**Pan**	298.2	2.5%	

Start Weight:	11800.4
End Weight:	11745.7
Washed Weight	298.2
D10:	0.29
D30:	2.00
D60:	7.50
Cu:	25.86
Cc:	1.84
Soil Classification:	GW or GP



REMARKS:

NTI MATERIALS TESTING LABORATORY

Engineers – Land Surveyors – Geologists
Construction Inspection – Materials Testing

NTI

717 SOUTH PEABODY, PORT ANGELES, WASHINGTON 98362, (360) 452-8491

Specimen Control #	18200

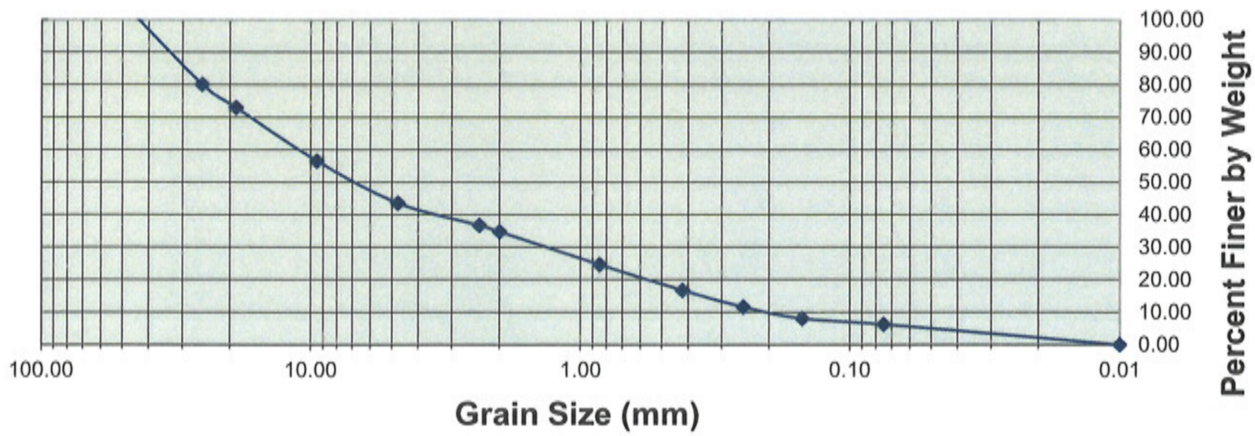
GRADATION SIEVE ANALYSIS

ASTM C-136

Client:	Zenovic & Associates	Date:	Collected on 8/2/2018
Project:	Ref#18252	Sample taken by:	Seth Rodman
BILLING INFORMATION		Material:	**#7**
Lab Account #:	ZZCLAB-22	Source:	
Client Contact:	Seth Rodman	Tested By:	S. West
Email:	zenovic@olympus.net	Date Tested:	9/20/2018
Phone#:	360-471-0501	Test requested:	Wet / Dry Sieve: WET
Remarks:		Reviewed:	D. Eaton

Sieve Dia (mm)	Sieve Size	Dry Wt. (grams)	% Retained	% Passing	
50.800	**2"**	0.0	0.0%	105.8%	
25.400	**1"**	3195.0	25.7%	80.1%	
19.000	**3/4"**	888.9	7.1%	73.0%	
9.510	**3/8"**	2045.1	16.4%	56.6%	
4.750	**#4**	1612.7	13.0%	43.6%	
2.380	**#8**	851.2	6.8%	36.8%	
2.000	**#10**	245.0	2.0%	34.8%	
0.850	**#20**	1260.7	10.1%	24.7%	
0.420	**#40**	975.4	7.8%	16.8%	
0.250	**#60**	645.5	5.2%	11.6%	
0.150	**#100**	437.2	3.5%	8.1%	
.075	**#200**	228.6	1.8%	6.3%	
0	**Pan**	781.4	6.3%		

Start Weight:	13166.7
End Weight:	12443.1
Washed Weight	723.6
D10:	0.20
D30:	1.40
D60:	10.20
Cu:	51.00
Cc:	0.96
Soil Classification:	SW(SM or SC) or SP(SM or SC)



REMARKS:

NTI MATERIALS TESTING LABORATORY

Engineers – Land Surveyors – Geologists
Construction Inspection – Materials Testing

NTI

717 SOUTH PEABODY, PORT ANGELES, WASHINGTON 98362, (360) 452-8491

Specimen Control #	18201

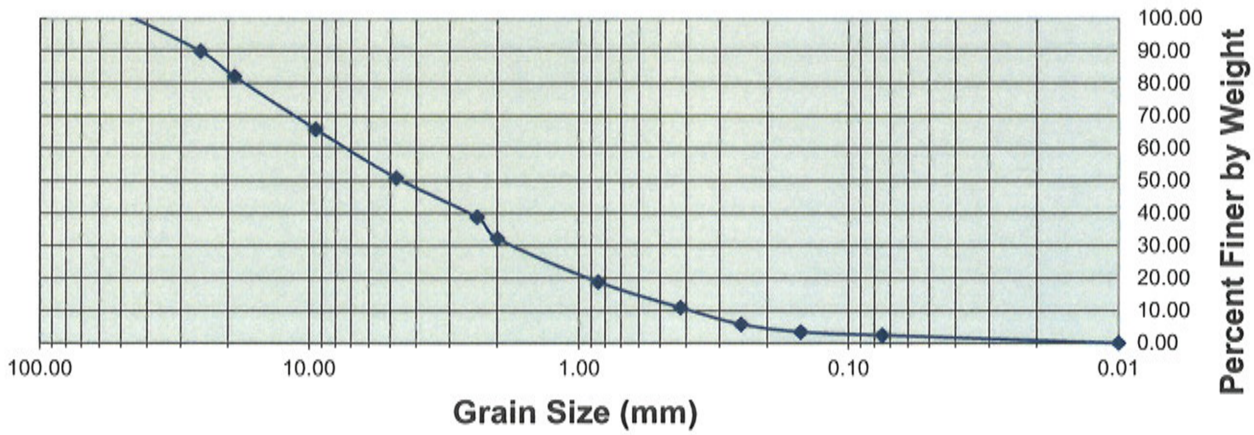
GRADATION SIEVE ANALYSIS

ASTM C-136

Client:	Zenovic & Associates	Date:	Collected on 8/2/2018
Project:	Ref#18252	Sample taken by:	Seth Rodman
BILLING INFORMATION		Material:	**#9**
Lab Account #:	ZZCLAB-22	Source:	
Client Contact:	Seth Rodman	Tested By:	S. West
Email:	zenovic@olympus.net	Date Tested:	9/19/2018
Phone#:	360-471-0501	Test requested:	Wet / Dry Sieve: WET
Remarks:		Reviewed:	D. Eaton

Sieve Dia (mm)	Sieve Size	Dry Wt. (grams)	% Retained	% Passing
50.800	**2"**	0.0	0.0%	102.2%
25.400	**1"**	1298.7	12.3%	89.9%
19.000	**3/4"**	824.2	7.8%	82.1%
9.510	**3/8"**	1717.4	16.2%	65.9%
4.750	**#4**	1588.1	15.0%	50.9%
2.380	**#8**	1280.8	12.1%	38.8%
2.000	**#10**	701.2	6.6%	32.2%
0.850	**#20**	1410.8	13.3%	18.8%
0.420	**#40**	833.3	7.9%	11.0%
0.250	**#60**	541.6	5.1%	5.8%
0.150	**#100**	255.1	2.4%	3.4%
.075	**#200**	105.6	1.0%	2.4%
0	**Pan**	256.3	2.4%	

Start Weight:	10813.1
End Weight:	10579.2
Washed Weight	233.9
D10:	0.37
D30:	1.80
D60:	7.40
Cu:	20.00
Cc:	1.18
Soil Classification:	GW or GP



REMARKS:

INFILTRATION RATE CALCULATION - GRAIN SIZE ANALYSIS	
PROJECT: Home Subdivision - Phase B	ZENOVIC & ASSOCIATES
LOCATION: Rolling Hills Way and Comfort Way	301 EAST 6TH STREET, SUITE 1
PARCEL NO: 03-30-30-59-0000	PORT ANGELES, WA 98362
	DATE: 8/5/2019
	JOB NO. 18252
	AUTHOR: SJR

Location	TP #2		
D_{10}	0.14	K_{sat}initial (cm/s)	0.023
D_{60}	7	CF_v	0.8
D_{90}	30	CF_t	0.4
%Fines	0.023	CF_m	0.9
		K_{sat}design (cm/s)	0.0066
		K_{sat}design (in/hr)	9.4

Location	TP #5		
D_{10}	0.29	K_{sat}initial (cm/s)	0.052
D_{60}	7.5	CF_v	0.8
D_{90}	25	CF_t	0.4
%Fines	0.025	CF_m	0.9
		K_{sat}design (cm/s)	0.0150
		K_{sat}design (in/hr)	21.3

Location	TP #7		
D_{10}	0.2	K_{sat}initial (cm/s)	0.026
D_{60}	10.2	CF_v	0.8
D_{90}	32	CF_t	0.4
%Fines	0.065	CF_m	0.9
		K_{sat}design (cm/s)	0.0074
		K_{sat}design (in/hr)	10.5

$$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$$

Total Correction Factor, $CF_T = CF_v \times CF_t \times CF_m$

K_{sat} design = K_{sat} initial X CF_T

Table 3.3.1
Correction Factors to be Used With In-Situ Saturated Hydraulic Conductivity Measurements to Estimate Design Rates.

Issue	Partial Correction Factor
Site variability and number of locations tested	CF_v = 0.33 to 1.0
Test Method Large-scale PIT Small-scale PIT Other small-scale (e.g. Double ring, falling head) Grain Size Method	 CF_t = 0.75 = 0.50 = 0.40 = 0.40
Degree of influent control to prevent siltation and bio-buildup	CF_m = 0.9

INFILTRATION RATE CALCULATION - GRAIN SIZE ANALYSIS		ZENOVIC & ASSOCIATES
PROJECT:	Home Subdivision - Phase B	301 EAST 6TH STREET, SUITE 1
LOCATION:	Rolling Hills Way and Comfort Way	PORT ANGELES, WA 98362
PARCEL NO:	03-30-30-59-0000	DATE: 8/5/2019
		JOB NO. 18252
		AUTHOR: SJR

Location	TP #9		
D_{10}	0.37	K_{sat} initial (cm/s)	0.074
D_{60}	7.4	CF_v	0.8
D_{90}	25	CF_t	0.4
%Fines	0.024	CF_m	0.9
		K_{sat} design (cm/s)	0.0213
		K_{sat} design (in/hr)	30.2

Location			
D_{10}		K_{sat} initial (cm/s)	
D_{60}		CF_v	0.8
D_{90}		CF_t	0.4
%Fines		CF_m	0.9
		K_{sat} design (cm/s)	
		K_{sat} design (in/hr)	

Location			
D_{10}		K_{sat} initial (cm/s)	
D_{60}		CF_v	0.8
D_{90}		CF_t	0.4
%Fines		CF_m	0.9
		K_{sat} design (cm/s)	
		K_{sat} design (in/hr)	

$$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$$

Total Correction Factor, $CF_T = CF_v \times CF_t \times CF_m$

K_{sat} design = K_{sat} initial X CF_T

Table 3.3.1
Correction Factors to be Used With In-Situ Saturated Hydraulic Conductivity Measurements to Estimate Design Rates.

Issue	Partial Correction Factor
Site variability and number of locations tested	CF_v = 0.33 to 1.0
Test Method Large-scale PIT Small-scale PIT Other small-scale (e.g. Double ring, falling head) Grain Size Method	 CF_t = 0.75 = 0.50 = 0.40 = 0.40
Degree of influent control to prevent siltation and bio-buildup	CF_m = 0.9

Appendix D

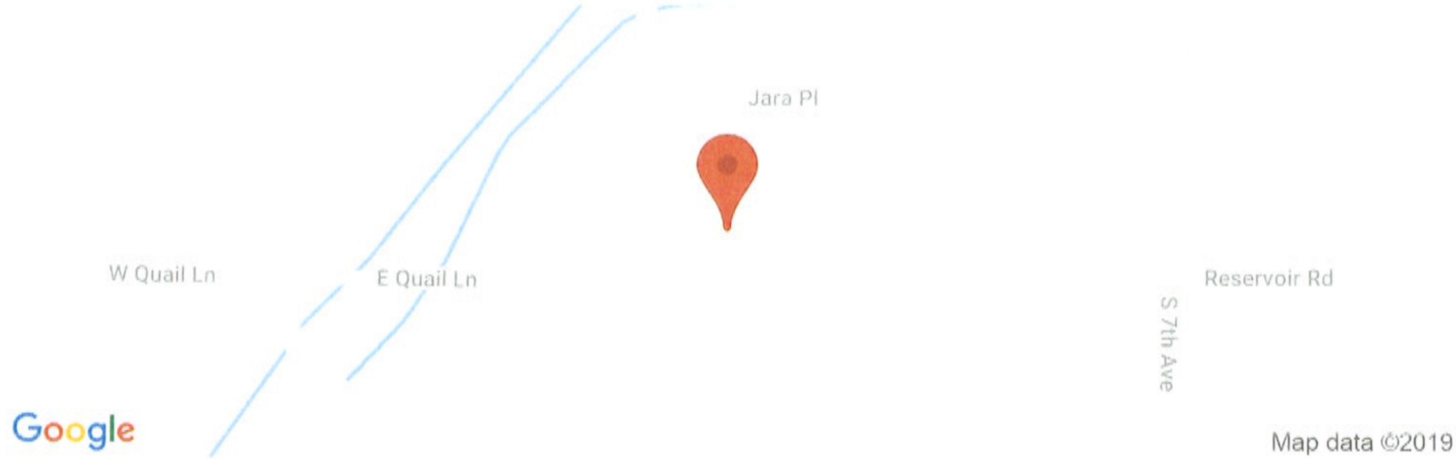
Geologic Maps and Seismic Information

My Map

Esri, NASA, NGA, USGS | WA State Parks GIS, Esri, HERE, Garmin, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA | Washington Division of Geology and Earth Resources

Home Subdivision - Phase B

Latitude, Longitude: 48.06547523, -123.12273163

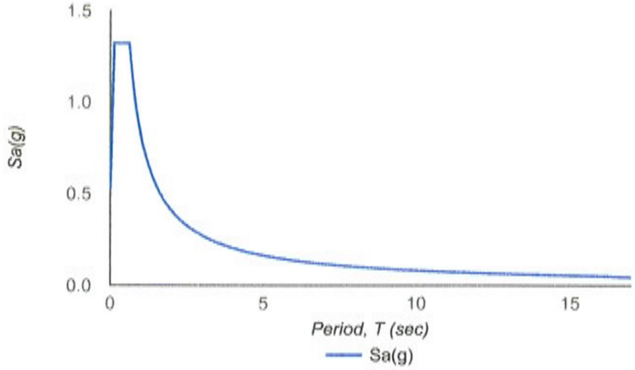


Date	8/2/2019, 11:32:02 AM
Design Code Reference Document	IBC-2015
Risk Category	II
Site Class	D - Stiff Soil

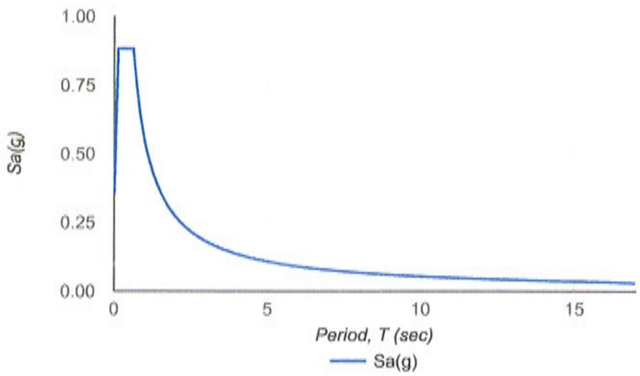
Type	Value	Description
S_S	1.323	MCE_R ground motion. (for 0.2 second period)
S_1	0.546	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.323	Site-modified spectral acceleration value
S_{M1}	0.819	Site-modified spectral acceleration value
S_{DS}	0.882	Numeric seismic design value at 0.2 second SA
S_{D1}	0.546	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	1.5	Site amplification factor at 1.0 second
PGA	0.554	MCE_G peak ground acceleration
F_{PGA}	1	Site amplification factor at PGA
PGA_M	0.554	Site modified peak ground acceleration
T_L	16	Long-period transition period in seconds
SsRT	1.323	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.359	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.546	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.587	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.6	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.974	Mapped value of the risk coefficient at short periods
C_{R1}	0.931	Mapped value of the risk coefficient at a period of 1 s

MCER Response Spectrum



Design Response Spectrum



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Appendix E

NRCS Soil Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Clallam County Area, Washington

July 31, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

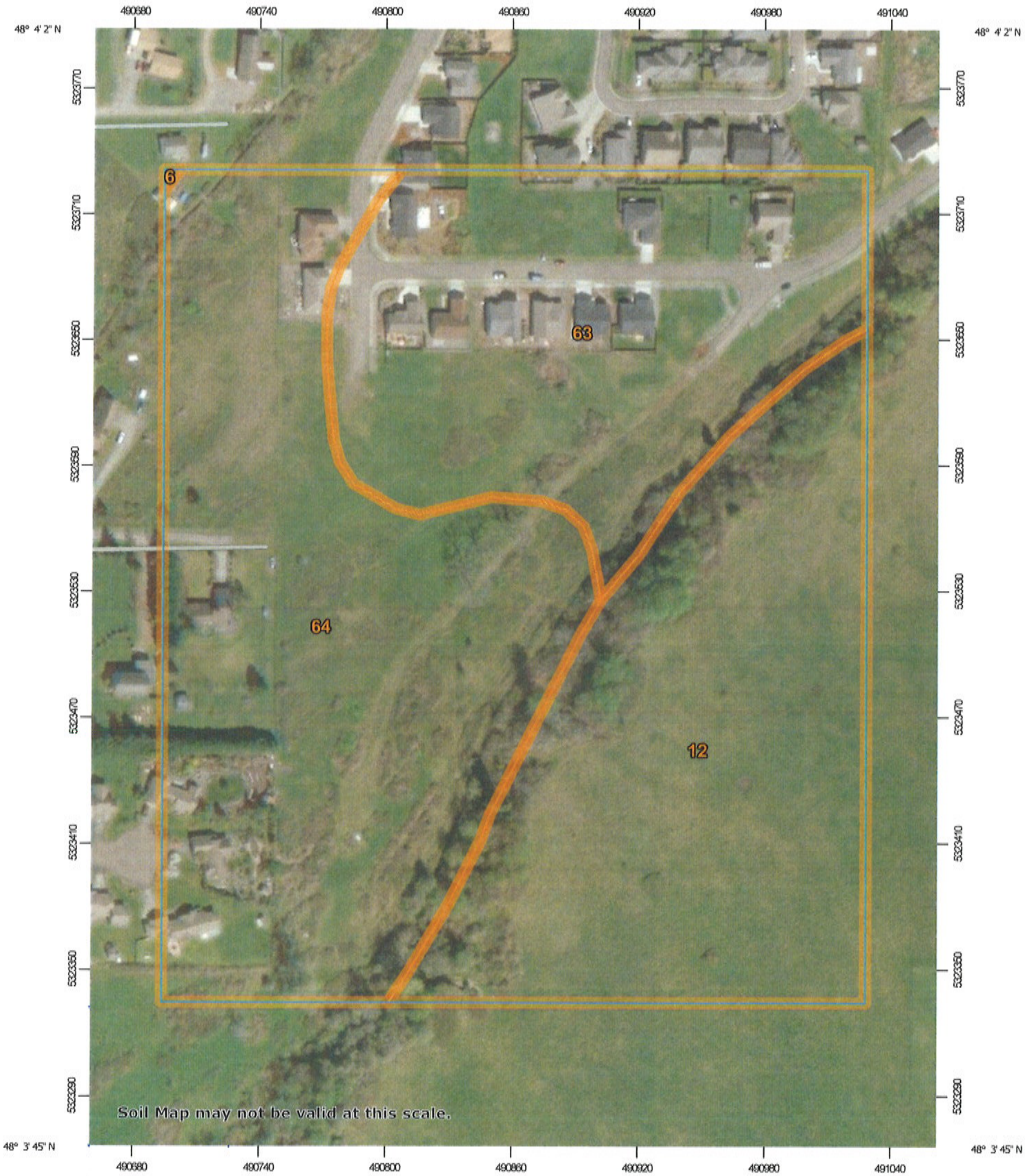
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

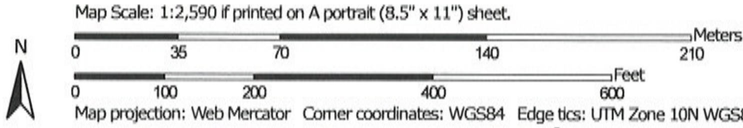
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:2,590 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Clallam County Area, Washington
Survey Area Data: Version 16, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Sep 29, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6	Carlsborg gravelly sandy loam, 0 to 5 percent slopes	0.0	0.0%
12	Clallam gravelly sandy loam, 0 to 15 percent slopes	10.7	32.4%
63	Sequim very gravelly sandy loam	9.0	27.3%
64	Sequim-McKenna-Mukilteo complex	13.3	40.3%
Totals for Area of Interest		**32.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Clallam County Area, Washington

6—Carlsborg gravelly sandy loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2gh7
Elevation: 50 to 500 feet
Mean annual precipitation: 20 inches
Mean annual air temperature: 48 degrees F
Frost-free period: 170 to 200 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Carlsborg and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Carlsborg

Setting

Landform: Alluvial fans, terraces
Parent material: Alluvium

Typical profile

H1 - 0 to 9 inches: gravelly sandy loam
H2 - 9 to 20 inches: very gravelly loamy sand
H3 - 20 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Forage suitability group: Droughty Soils (G002XN402WA)
Hydric soil rating: No

12—Clallam gravelly sandy loam, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2gfc
Elevation: 40 to 1,800 feet
Mean annual precipitation: 23 inches

Mean annual air temperature: 48 degrees F
Frost-free period: 160 to 200 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Clallam and similar soils: 85 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Clallam

Setting

Landform: Hillslopes
Parent material: Till

Typical profile

H1 - 0 to 10 inches: gravelly ashy sandy loam
H2 - 10 to 28 inches: very gravelly ashy sandy loam
H3 - 28 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 20 to 40 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: C
Forage suitability group: Limited Depth Soils (G002XN302WA)
Hydric soil rating: No

Minor Components

Mckenna

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

63—Sequim very gravelly sandy loam

Map Unit Setting

National map unit symbol: 2ghc
Elevation: 20 to 300 feet
Mean annual precipitation: 18 inches

Mean annual air temperature: 48 degrees F
Frost-free period: 170 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Sequim and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sequim

Setting

Landform: Terraces, alluvial fans
Parent material: Alluvium

Typical profile

H1 - 0 to 10 inches: very gravelly sandy loam
H2 - 10 to 23 inches: extremely cobbly loamy sand
H3 - 23 to 60 inches: extremely cobbly sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Forage suitability group: Droughty Soils (G002XN402WA)
Hydric soil rating: No

64—Sequim-McKenna-Mukilteo complex

Map Unit Setting

National map unit symbol: 2ghd
Elevation: 100 to 300 feet
Mean annual precipitation: 18 to 70 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 150 to 250 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Sequim and similar soils: 35 percent
Mckenna and similar soils: 35 percent
Mukilteo and similar soils: 20 percent
Minor components: 3 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sequim

Setting

Landform: Terraces, alluvial fans
Parent material: Alluvium

Typical profile

H1 - 0 to 10 inches: very gravelly sandy loam
H2 - 10 to 23 inches: extremely cobbly loamy sand
H3 - 23 to 60 inches: extremely cobbly sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Forage suitability group: Droughty Soils (G002XN402WA)
Hydric soil rating: No

Description of Mckenna

Setting

Landform: Terraces, depressions
Parent material: Glacial drift

Typical profile

H1 - 0 to 8 inches: gravelly ashy silt loam
H2 - 8 to 18 inches: gravelly loam
H3 - 18 to 24 inches: very gravelly loam
H4 - 24 to 32 inches: very gravelly sandy loam
H5 - 32 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: 20 to 40 inches to densic material
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w

Hydrologic Soil Group: D
Forage suitability group: Wet Soils (G002XN102WA)
Hydric soil rating: Yes

Description of Mukilteo

Setting

Landform: Terraces, depressions
Parent material: Mixed organic material

Typical profile

H1 - 0 to 10 inches: muck
H2 - 10 to 60 inches: mucky peat

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 0 to 10 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Very high (about 26.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Forage suitability group: Wet Soils (G002XN102WA)
Hydric soil rating: Yes

Minor Components

Bellingham

Percent of map unit: 3 percent
Landform: Depressions
Hydric soil rating: Yes

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